case that nothing is displayed) represents the lower intensity of the irradiation light. Thus, according to the tactile display device of the present invention, it is possible to use the display pattern, which is visual information, as a light source of the irradiation light for presenting the tactile information. Therefore, it is possible to present the tactile information extremely efficiency.

[0017] On the other hand, in the tactile display device of the present invention, at least one of the conductivity and the magnetic permeability of the characteristic change layer changes at each part on the display screen. The expression "at each part" herein is contemplated to refer to a condition that an entire surface of the characteristic change layer does not change evenly or equally. Therefore, the conductivity or the magnetic permeability does not always change in accordance with the display pattern displayed on the display screen, or analogously with the display pattern. In order to display the tactile information in association with the visual information to a certain extent, however, the change in or of the conductivity or the magnetic permeability preferably resembles to the display pattern displayed on the display screen at least. From this point of view, the characteristic change layer preferably exhibits an anisotropic nature with lower electric resistance in a direction perpendicular to the substrate (or display screen) and higher electric resistance in a direction parallel to the substrate (or display screen).

[0018] Incidentally, if the conductivity of the characteristic change layer is excessive, the voltage distribution hardly arises in a plane of the characteristic change layer, and thereby in a plane of the electrorheological fluid layer. Therefore, it is preferable that the electrical resistance at a part of the characteristic change layer where no irradiation light (display light) reaches is sufficiently and considerably high.

[0019] Furthermore, the same discussion can be applied to the electrorheological fluid layer which is disposed opposite to the characteristic change layer. The viscosity of the electrorheological fluid layer also changes at each part on the display screen, in response to the applied voltage. The expression "at each part" in this context is also contemplated to refer to a condition that an entire surface of the electrorheological fluid layer does not change evenly or equally. That is, the viscosity does not always change in accordance with the display pattern displayed on the display screen, or analogously with the display pattern, insofar as the operator can feel any difference, for example, soft or hard, when touching the corresponding element. In order to recognize or feel the display pattern visually and tactily, however, the viscosity change preferably resembles to the display pattern at least. Therefore, the electrorheological fluid layer preferably exhibits an anisotropic nature with lower electric resistance in a direction perpendicular to the substrate (e.g. characteristic change layer) and higher electric resistance in a direction parallel to the substrate (e.g. characteristic change layer), so that the tactile information is presented or displayed in accordance with the display light as precise as possible.

[0020] Incidentally, if the conductivity of the electrorheological fluid layer is high, the voltage difference distribution hardly arises at each point in a plane of the electrorheological fluid layer. Therefore, it is even preferable that the electrorheological fluid layer is dielectric and the thickness thereof is extremely thin (so that the electrical resistance in a direction perpendicular to the substrate is extremely lower than that in a direction parallel to the substrate).

[0021] Incidentally, the thickness of the electrorheological fluid layer, the thickness of the characteristic change layer, the intensity of the display light, the applied voltage and so on, which are important to display such a tactile information, are respectively predetermined, experimentally, empirically otherwise via simulation, in view of a shape or tactile impression of the tactile information to be displayed, as well as an apparatus size required for the entire tactile display device.

[0022] Incidentally, the expression "having a light transmissive property" herein is contemplated to include everything other than object or element having an optical impermeability. Therefore, it is not contemplated to define a precise range of the optical permeability.

[0023] Incidentally, insofar as the characteristic change layer of the present invention has properties herein disclosed, the constitutional material, as well as a range of changing the conductivity or the magnetic permeability, is not limited in any sense.

[0024] In an aspect of the tactile display device, said characteristic change layer is a photoconductive layer, the conductivity of which changes at each part on the display screen in response to the intensity of the display light.

[0025] According to this aspect, it is relatively easy to achieve one or more properties required for the characteristic change layer by employing a photoconductive layer, such as a semiconductor layer with a higher electrical resistance without any irradiation light, as the characteristic change layer.

[0026] In another aspect of the tactile display device, there is further provided with an elastic layer beneath said electrorheological fluid layer above the display screen, said elastic layer having elastic modulus less than that of said electrorheological fluid layer.

[0027] In the tactile display device of the present invention, if the thickness of the electrorheological fluid layer realizing the tactile display is excessively thick, the applied voltage tends to be excessively high although the tactile impression is improved. If the thickness is excessively thin, the tactile impression is hardly obtained satisfactorily although the required applied voltage is decreased.

[0028] According to this aspect, since there is provided with the elastic layer beneath the electrorheological fluid layer above the display screen, in which the elastic modulus of the elastic layer is less than that of the electrorheological layer, it is possible to improve the tactile impression for the operator and display the higher quality tactile information efficiently.

[0029] In another aspect of the tactile display apparatus, the apparatus is further provided with a flexible substrate having a light transmissive property, wherein said pair of electrodes, said characteristic change layer and said electrorheological fluid layer are disposed above said flexible substrate.

[0030] According to this aspect, the operator can suitably feel or recognize the tactile information resulted from the